

A Transaction Data Study of The Forward Bias Puzzle

Francis Breedon

Dagfinn Rime

Paolo Vitale

f.breedon@imperial.ac.uk dagfinn.rime@norges-bank.no p.vitale@unich.it

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Motivation and Results

Motivation

- The **forward rate bias** is a puzzle in international finance.
- The **market microstructure approach** to exchange rates provides some rationale for the **disconnect** puzzle.
- We investigate whether similar headway can be made on the **forward bias** puzzle.

Results

- Via a market microstructure framework the forward bias is decomposed in parts due to **forecast error** and **risk premium**.
- Order flow *affects* the **risk premium**.
- **Carry trade** generates order flow and explains part of the **bias**.



Data

- Transactions data for the period 2/1/1997 to 1/5/2007 from EBS pertaining to inter-dealer trades for the major currencies.
 - ★ Data indicates the *number of customer initiated* buys and sells and the corresponding *prices*.
- Reuters's survey of *individual* market participants' forecasts for EUR/USD, USD/JPY and GBP/USD rates.
 - ★ Each month about 50 market participants provide their forecasts of future exchange rates.
 - ★ The forecast horizons are 1, 3, 6 and 12 months.



Fama's Regression: Monthly Data

GMM estimates of the slope coefficient β (t -statistics in parentheses) in the regression

$$s_{t+1} - s_t = \alpha + \beta (f_t - s_t) + \epsilon_{t+1}$$

. In blue significantly smaller than 1 values.

Currency	1 month	3 months	6 months	1 year
	Realized Return			
EUR/USD	-4.81 (-2.59)	-4.92 (-3.13)	-5.08 (-4.29)	-5.24 (-6.02)
USD/JPY	-1.87 (-1.19)	-1.61 (-1.09)	-1.76 (-1.48)	-1.85 (-2.34)
GBP/USD	-2.51 (-1.30)	-2.04 (-1.23)	-1.95 (-1.36)	-2.19 (-1.90)



Fama's Regression: Monthly Data

GMM estimates of the slope coefficient β (t -statistics in parentheses) in the regression

$$s_{t,e} - s_t = \alpha + \beta(f_t - s_t) + \epsilon_t.$$

In blue significantly smaller than 1 values.

Currency	1 month	3 months	6 months	1 year
	Expected Return			
EUR/USD	-3.60 (-1.87)	-0.77 (-1.10)	0.32 (0.74)	0.64 (1.86)
USD/JPY	-2.87 (-1.80)	-1.404 (-1.75)	-0.43 (-0.72)	-0.04 (-0.09)
GBP/USD	-1.35 (-0.64)	0.01 (0.01)	0.33 (0.76)	0.47 (1.47)



Order flow and Modified UIP

Definition (Order Flow)

Order flow (o_t) is the difference between buyer and seller initiated transactions in the market for the foreign currency.

- Dealers aggregate demand as function of excess return

$$o_t = v_t \left(\bar{E}_t^1 [\tilde{s}_{t+1}] - s_t - (i_t - i_t^*) \Delta t \right)$$

- $\bar{E}_t^1 [\tilde{s}_{t+1}]$ is **average expectation**; v_t is average trading intensity, function of **risk aversion** and **uncertainty**.
- Modified UIP**:

$$\bar{E}_t^1 [\tilde{s}_{t+1}] - s_t = (i_t - i_t^*) \Delta t + o_t / v_t.$$

Risk Premium (RP): o_t / v_t .



The Decomposition of Fama's Beta

Reconsider Fama's regression,

$$s_{t+1} - s_t = \alpha + \beta (f_t - s_t) + \varepsilon_{t+1}, \text{ with } \beta = \frac{\text{cov}(s_{t+1} - s_t, f_t - s_t)}{\text{var}(f_t - s_t)}$$

Given the **modified UIP**, inserting the **forecasting error**,

$u_{t+1} = s_{t+1} - E_t[s_{t+1}]$, it follows

$$s_{t+1} - s_t = (f_t - s_t) + o_t/v_t + u_{t+1}.$$

Fama's Beta Decomposition

Fama's coefficient β can be decomposed as follows,

$$\beta = 1 + \beta_o + \beta_u,$$

where

$$\beta_o = \frac{\text{cov}\left(\frac{1}{v_t} o_t, f_t - s_t\right)}{\text{var}(f_t - s_t)}, \quad \beta_u = \frac{\text{cov}(u_{t+1}, f_t - s_t)}{\text{var}(f_t - s_t)}.$$



The Decomposition of Fama's Beta (cont.ed)

Beta Decomposition (Monthly Data, Jan '97 – Apr '07)

Coefficient values of β_o and β_u (with t -statistics in parentheses).
Sample: Jan 1997 - Apr 2007.

	EUR/USD		USD/JPY		GBP/USD	
	OF	ExpE	OF	ExpE	OF	ExpE
1 Month	-4.25 (-3.44)	-1.06 (-1.28)	-3.97 (-3.21)	0.92 (1.04)	-0.10 (-0.08)	-1.47 (-2.09)
3 Month	-2.63 (-2.55)	-3.11 (-2.18)	-2.70 (-2.26)	-0.61 (-0.39)	-0.54 (-0.72)	-2.27 (-1.52)
6 Month	-2.81 (-3.14)	-3.62 (-2.37)	-3.23 (-2.70)	-0.76 (-0.48)	-0.35 (-0.58)	-2.74 (-1.61)
12 Month	-2.80 (-3.43)	-4.21 (-2.81)	-4.23 (-4.44)	-0.14 (-0.12)	0.29 (0.64)	-4.11 (-2.72)



Carry Trade: Order Flow, Profits and Crash Risk

For the EUR/USD and USD/JPY:

- Carry trading *generates* order flow:

$$o_t = \alpha_o + \beta_o fd_{t-1} + \epsilon_t^o, \beta_o < 0 \text{ (Table 4).}$$

- Carry traders *expect* profits from carry trading:

$$r_{e,t} = \alpha_{er} + \beta_{er} fd_t + \epsilon_t^{er}, \beta_{er} < 1 \text{ (Table 1, Panel B).}$$

- Expectations of carry trading profits *generate* order flow:

$$o_t = \alpha_o + \lambda_o r_{e,t-1} + \epsilon_t^o, \lambda_o > 0 \text{ (Table 5).}$$

- Order flow *affects* expected risk-premia:

$$s_{t,e} - f_t = \alpha_{ep} + \gamma_{ep} o_t + \epsilon_t^{ep}, \gamma_{ep} > 0 \text{ (Table 6).}$$

- Carry trade *increases* crash risk:

$$\text{skew}_t = \alpha_{sk} + \gamma_{sk} o_t + \beta_{sk} fd_{t-1} + \delta_{sk} \text{ImpVol}_{t-1} + \epsilon_t^{sk}$$

$\gamma_{sk} < 0 \text{ (Table 7).}$



The Impact of the Expected Return on Order Flow

Risk-Adjusted Order Flow (Monthly Data, Jan '97 – Apr '07)

$$o_t = \alpha_o + \lambda_o r_{e,t-1} + \epsilon_t^o \text{ (t-statistics in parentheses).}$$

	1 month	3 month	6 month	12 month
EUR/USD	0.00 (0.02)	0.26 (2.78)	0.56 (2.85)	0.80 (2.46)
USD/JPY	0.11 (0.97)	0.90 (3.10)	1.42 (2.51)	1.64 (1.66)



Order Flow and the Time-Varying Risk Premium

Expected Risk Premium (Monthly Data, Jan '97 – Apr '07)

$$s_{t,e} - f_t = \alpha_{ep} + \gamma_{ep} o_t + \eta_t^{ep} \quad (t\text{-statistics in parentheses}).$$

	Horizon			
	1 month	3 months	6 months	1 year
EUR/USD	0.198 (1.04)	0.212 (2.82)	0.100 (2.24)	0.027 (0.92)
USD/JPY	0.054 (0.35)	0.154 (3.54)	0.150 (3.32)	0.153 (5.89)



Not a Free Lunch: Crash Risk

Realized Skewness (Monthly Data, Jan '97 – Apr '07)

$$skew_t = \alpha_{sk} + \gamma_{sk} o_t + \beta_{sk} fd_{t-1} + \delta_{sk} ImpVol_{t-1} + \epsilon_t^{sk}$$

(*t*-statistics in parentheses).

	EUR/USD			USD/JPY		
	OF	FD	IV	OF	FD	IV
1 Month	-13.78 (-1.85)	37.88 (0.78)	-1.14 (-0.40)	-3.07 (-0.58)	48.10 (2.08)	-0.19 (-0.10)
3 Month	-5.97 (-1.88)	9.40 (0.50)	-8.55 (-2.58)	-4.25 (-2.21)	34.92 (4.50)	4.54 (2.69)
6 Month	-3.94 (-2.01)	4.72 (0.45)	-7.03 (-1.82)	-2.90 (-4.08)	22.78 (5.83)	6.86 (4.28)
12 Month	-1.27 (-1.16)	5.85 (0.99)	-6.10 (-1.41)	-1.29 (-4.03)	7.97 (5.40)	4.41 (2.99)



Conclusions

- Order flow explains a large share of expected risk premia.
- Order flow is partly carry motivated.
- Decomposing Fama's beta we explain the forward bias with:
 - ★ Forecast errors (shown before);
 - ★ Carry-motivated order flow (new result).

